

Consumption, Silicosis, and the Social Construction of Industrial Disease*

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In the wake of the bacterial revolution after Robert Koch identified the tuberculosis bacillus, medical and public health professionals classified the various forms of consumption and phthisis as a single disease—tuberculosis. In large measure, historians have adopted that perspective. While there is undoubtedly a great deal of truth in this conceptualization, we argue that it obscures almost as much as it illuminates. By collapsing the nineteenth-century terms *phthisis* and *consumption* into tuberculosis, we maintain that historians have not understood the effect of non-bacterial consumption on working-class populations who suffered from the symptoms of coughing, wasting away, and losing weight.

In this essay, we explore how, in the nineteenth century, what we now recognize as silicosis was referred to as miners' "con," stonecutters' phthisis, and other industry-specific forms of phthisis and consumption. We examine how the later and narrower view of the bacterial origins of tuberculosis limited the medical professions' ability to diagnose and understand diseases caused by industrial dust. This paper explores the contention that developed at the turn of the century over occupational lung disease and tuberculosis and the circumstances that led to the unmasking of silicosis as a disease category.

In recent years, historians have examined the enormous effect that tuberculosis has had on American society. They have described how, in the mid-nineteenth century, the disease was romanticized in Victorian novels and was understood to affect middle- as well as working-class populations. By the early twentieth century, the disease was associated in the popular imagination with poverty and crowded working and living conditions. Historians have also identified tuberculosis as a disease associated with the workplace. They have detailed how overworked, underpaid workers toiled in harsh, dark, and crowded workplaces and were thus susceptible to infection by a bacillus that prospered under insanitary conditions. Throughout most of the nineteenth century, workers and physicians referred to the constellation of symptoms associated with the disease as phthisis or consumption. In the wake of the bacterial revolution after Robert Koch identified the tuberculosis bacillus, the medical profession and public health professionals identified the various forms of consumption as a single disease—tuberculosis. In large measure, historians have adopted that perspective. While there is undoubtedly a great deal of truth in this conceptualization, we argue that it obscures almost as much as it illuminates. By collapsing phthisis and consumption into tuberculosis, historians have distorted the

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nineteenth-century meaning of the terms *consumption* and *phthisis*. As a result, we have not understood their effect on the varied populations who suffered from the symptoms of coughing, wasting away, and losing weight. In addition, we have shrouded the relationship between silicosis, an acknowledged industrial disease, and tuberculosis.

In this essay, we explore how, in the nineteenth century, what we now recognize as silicosis was referred to as miners' "con," stonecutters' phthisis, and other industry-specific forms of phthisis and consumption. We examine how the later and narrower view of the bacterial origins of tuberculosis limited the medical professions' ability to diagnose and understand diseases caused by industrial dust. This paper also explores the contention that developed at the turn of the century over occupational lung disease and tuberculosis and the circumstances that led to the unmasking of silicosis as a disease category [1].

Early in the twentieth century, officials of the Granite Cutters' Union in Barre, Vermont, complained that consumption, "the white man's scourge," was "claiming almost every granite cutter in this vicinity, before he reaches the age of fifty." It was obvious to the union that the cause of the epidemic was the granite dust inhaled while carving, chipping, and finishing monuments, gravestones, and building facades. The local physicians agreed that the workers were suffering from consumption, but they differed in their understanding of its cause. The profession assumed that the workers' consumption was caused by tiny germs that spread among the work force as a result of poor personal hygiene and unsanitary living conditions.

The physicians had begun to refer to consumption as tuberculosis. The union and the work force, however, insisted on using the older nineteenth-century terms "consumption" or "phthisis" to describe the condition. There was nothing new or complex about what was causing them to cough, wheeze, spit blood, and waste away: Physicians "have given the old-time consumption a new name," the union observed, "and talk learnedly about it, but what does that amount to when men are dying in our midst almost daily of this fell disease." Writing that the rate of disease should "strike terror to the heart of every granite cutter," the union declared that the focus of attention should be on prevention of the dusty conditions and control over the speed of work because "the men work at a faster clip than the constitution of any human machine is able to stand up to" [2].

Despite the fact that the term "silicosis" would not be widely used in the United States until after 1915, dust had been long recognized as a problem for hard-rock miners, cutters, potters, buffers, glass workers, sandblasters, and foundry workers [3]. Since antiquity, observers had recognized that workers developed serious breathing problems when they inhaled the dust of certain rocks and minerals. Throughout most of the nineteenth century, doctors and laymen alike had accepted dust as a source of phthisis or, more commonly, consumption, chronic lung conditions that affected broad cross-sections of western European and American society. For the previous two centuries, this condition was the single greatest cause of death in Europe and America. Despite the great attention to epidemics of smallpox, cholera, or typhoid, consumption was "the great white plague" that threatened "the very survival" of European and American society. The symptoms of wasting away,

coughing, spitting, and weakening might appear in victims from various classes and social strata.

Before the acceptance of the germ theory, practitioners and laymen alike understood disease in highly personal and idiosyncratic terms. Much of medical therapeutics rested on the belief that disease was a reflection of individuals' special social, personal, hereditary, and economic circumstances. People's maladies were based, in part, on the peculiarities of the individual and his or her life. As Charles Rosenberg has written, "the body was seen, metaphorically, as a system of dynamic interactions with its environment. Health or disease resulted from a cumulative interaction between constitutional endowment and environmental circumstance" [4]. As John Warner has argued, it was the special relationship between an individual and a complex, highly particularized environment that was at the root of illness. The practitioner's therapeutic skills were measured by his or her ability to weigh, evaluate, and differentiate the patient from others who might have similar symptoms.

The diagnosis and treatment of consumption, also commonly called phthisis, developed within this general medical milieu. Those suffering from the common symptoms of coughing, wheezing, and spitting blood, all had phthisis. The disease took on different meanings for different classes and groups in the ever-changing urban and industrial societies of western Europe and the United States. Physicians "faced with a confusing array of signs and symptoms, bearing no obvious relation to one another," saw these signs as "the expression of different maladies." For middle-class sufferers the disease was often presented in almost a romantic light. The translucent flush of Victorian ladies suffering from this disease became a standard image in the nineteenth-century novel. For the working class, however, the disease had a much more threatening aspect: workers and their families huddled together in the slum dwellings of large cities such as London, Paris, and New York [5].

The apparent idiosyncrasy of the symptoms that marked phthisis during most of the first half of the nineteenth century reinforced standard ideas regarding the nature, course, and treatment of disease. Phthisis could be linked to the ongoing, long-term moral and social environment that predisposed a victim to a disease process. Medical practitioners and the public as well shared a common set of assumptions about the cause and treatment of the disease. Phthisis could be rooted in personal behavior such as drinking, social position, poor living quarters, malaise of urban life style, and, finally, indoor, unhealthful work. As Warner notes, "Treatment was to be sensitively gauged not to a disease entity but to such distinctive features of the patient as age, gender, ethnicity, socioeconomic position, and moral status, and to attributes of place like climate, topography and population density" [6]. A practitioner needed to have a complete knowledge of the life history of the patient in order to make an accurate diagnosis and plan of treatment.

Researchers had documented the importance of a variety of sources for phthisis. Among them were the home, crowding, impure air, and dust in the workplace. In descriptions of various dusty trades, it was commonly pointed out that phthisis and consumption were caused by the industry. In an *Industrial History of the United States*, published in 1878, the author described the sources of "grinders' consumption" in the axe industry: because of "the constant inhalation of the grit and bits of steel thrown off in the process . . . a premature death is rarely averted" [7].

Consumption or phthisis was a term used to denote a wide variety of symptoms.

The disease could be of an acute nature and “prove fatal in a few weeks.” Or it might start with acute symptoms and evolve into a chronic condition. Alternatively, its symptoms might appear slowly, gradually getting worse over many years. Furthermore, it could affect lungs, bones, the brain, and other organs of the body.

In the years following Pasteur’s work on rabies and yeast, the medical community began to change its view regarding the multiple sources of illness. Increasingly, laboratory science began to hold out the possibility that disease could be explained rationally through the discovery of specific microorganisms.

The discovery of the tuberculosis bacillus was perhaps the most dramatic confirmation of the significance of the concept of the germ. In the years following Koch’s discovery, medical history became a listing of physiological and hereditary factors that might explain the symptom. “In attempting to arrive at a correct solution of the problem,” noted one physician explaining the method of diagnosing tuberculosis in 1904, “the greatest care should always be exercised to ascertain . . . carefully all the facts that can be learned concerning the patient’s past history and mode of life.” While in the middle years of the nineteenth century this admonition might have meant exploring personal behavior, work history, and living conditions, by now it simply meant examining “the probable duration of the disease, the occurrence of a foregoing haemoptysis, a history of an attack of typhoid, pneumonia, pleurisy, or protracted influenza, and, to a certain extent the individual’s appearance” [8]. The effect of this changing medical culture was critical in the study of phthisis [9]. According to Ludwig Teleky, a noted industrial physician and author of the first history of industrial hygiene, by the year of Koch’s discovery there was “a vast knowledge of [the importance of] dust on the lungs.” But now, suddenly, the study of its industrial etiology ceased: “At that time . . . the study of the effects of dust stopped. All cases [of phthisis] were diagnosed as tuberculosis.” Researchers “mocked at all those ‘curiosities’ of quartz lungs, coal lungs, and iron lungs, ‘all of which belong in a cabinet of curiosities than in industrial hygiene’ ” [10]. All consumption or phthisis came to be understood as tuberculosis, caused by a specific organism and spread like other infectious diseases. “Medical science claims that the presence of the tubercle bacillus in the lungs is the fundamental cause of phthisis, or consumption,” trumpeted a New Yorker writing to *Scientific American* in 1904 [11].

With the revolution in bacteriology that followed the discoveries of Pasteur, Lister, and Koch in the middle decades of the century, however, “Bacteriology thus became an ideological marker, sharply differentiating the ‘old’ public health, the province of untrained amateurs from the ‘new’ public health, which belonged to scientifically trained professionals.” Despite the different professional mandates of public health workers and physicians, both groups of professionals began to share a common faith in the significance of the disease-specific germ entity in creating consumption. The implications for medical and public health understanding was that the modes of transmission of the bacteria had to be clearly identified and an effective campaign to eliminate the specific *sources* of the disease was to be mounted. It seemed that the older generation’s emphasis on cleaning up the general environment was misdirected and inefficient. One of the advocates of the new public health summed up the revolution in ideology that overtook the field in the 1880s: “Before 1880 we knew nothing; after 1890 we knew it all; it was a glorious ten years” [12].

There was almost universal agreement among medical and public health personnel about the etiology of phthisis [13]: the bacillus, not dust per se, made people sick.

Although metallic and mineral dusts might be injurious to workers' lungs, they were merely a small problem in comparison to the dangers posed by bacterial infection [14]. One authority stated: "Dusts, . . . though they ought . . . to be kept away from workpeople, as a preventive measure against consumption, are yet only remotely a cause of the disease" [15].

It was not that the new medical and public health viewpoints completely ignored dust as a factor in the creation of phthisis. But dust's importance was in its role as a vehicle that carried the bacillus from victim to victim. One physician summarized the general understanding of the relationship between dust and tuberculosis by noting that "inhalation is probably the common mode of infection, and that indirectly through infected dust with which the air is laden" [16].

Just as the field had developed unanimity and clarity regarding how to define and explain "true" phthisis, Thomas Oliver and British governmental investigators published a series of studies that had a major effect on some American reformers, public health workers, and statisticians. Oliver and others argued that non-infectious cases of lung disorders were more important than previously assumed. In 1902, Oliver, in his famous treatise on the *Dangerous Trades*, noted "the tendency of modern pathology is to look upon all pulmonary phthisis or consumption as tuberculosis, but the fact remains that phthisis can be caused by dust." He explained that these pneumoconioses had been neglected but that they were significant for large cross-sections of the working population. "The affected workman is regarded as the victim of consumption, but the disease is not necessarily tuberculosis," he warned.

By 1906, some British researchers had developed a new theory about phthisis that challenged the bacteriological model. It was not one disease. Rather, there were three distinct conditions producing similar symptoms: "pulmonary disease manifests itself in three kinds or forms—as ordinary tuberculous phthisis, acute or chronic; as 'fibroid phthisis,' and as a mixed form when a tuberculous process is ingrafted sooner or later upon the fibroid" [17]. The British Committee on Compensation for Industrial Diseases took pains to distinguish between "fibroid phthisis" and the tuberculosis kind. "The first symptom [of fibroid phthisis] is a cough which insidiously and for a while almost imperceptibly becomes habitual. At first in the morning only, it gradually becomes more frequent during the day, and expectoration, nominal at the beginning, becomes more marked, though not profuse until the latter stages of the disease."

During the first decade of the twentieth century, most medical and public health professionals in the United States were still wedded to a bacteriological model that posited the unity of tuberculosis and phthisis. But others were developing competing models of the causes of sickness. Workers in the dusty trades, isolated from the new ideology of medicine and public health, continued to see their suffering as rooted in the terrible conditions of work. They still accepted the pre-bacteriological consensus that phthisis was linked to individual circumstance. Rather than emphasizing personal morality, susceptibility, or habit, however, they emphasized social factors such as work and living conditions. The explosion of job actions, labor unrest, and strikes at the turn of the century cannot be understood without looking into the disintegration of the work environment and concurrent increase in accidents and disease that paralleled the intensification of work and the introduction of power tools in the dusty trades. Miners suffering from constricted breathing called their disease alternately miners' phthisis or miners' consumption; potters called their affliction potters'

consumption or phthisis; other workers identified their symptoms as grinders' rot, glassblowers' con, granite cutters' phthisis, and so on. There was no attention to the bacteria in the descriptions of their conditions, but there was a great deal of attention to the specific industry that caused the sickness. Even industry spokespeople accepted the industrial origins of workers' complaints. They continued to use the terms phthisis, consumption, and tuberculosis interchangeably, with little regard to the differentiation between bacterial and non-bacterial lung disorders. *The Iron Age*, a trade journal, pronounced "Miners' phthisis is so great an evil" that it was essential to deal effectively with "this most terrible form of tuberculosis" [18].

The bacteriological consensus was also undermined by a diverse group of Progressive-era reformers who were developing a broader conception of the origins of phthisis. For reformers concerned with the plight of the urban poor, the effect of tuberculosis was obvious and profound and could not be divorced from the terrible conditions of life and work. Charity and settlement house workers, for example, documented that nearly one out of every four dwellings in New York City in 1890 experienced a death from phthisis. In the poorer neighborhoods, it was clear, the toll was much higher, leaving these communities devastated by the disease [19]. For these reformers, phthisis was a disease of poverty, not of germs. One of the leading social welfare reformers of the time, Graham Taylor, declared that tuberculosis was a "disease of the working classes" and that "everything which makes the life of the workingman harder, everything which is attendant upon poverty, makes for the increase of this disease" [20]. The interplay of "Housing, playgrounds, diet, income, . . . physical education, and immigration" and even dental hygiene "appear to be very diverse if not incongruous topics." But, when "grouped about the central idea of promoting immunity their interdependence becomes obvious" [21].

The social reform analysis that intimately linked social conditions and disease creation led settlement house workers and labor leaders to emphasize the connection between work and tuberculosis [22]. "Where there is dirt and grime and dust, long hours, foul air and bad pay, the community pays for what it calls cheap prices by a little money and many lives sacrificed to greed, ignorance and indifference," said a representative of labor in 1906. Labor called for factory inspection, good wages, "fresh air into our shops," and other factory legislation to address the problem of workers' health [23]. Graham Taylor saw four "characteristics of employment" that put workers at risk: "insanitary conditions," "low rate of wages," "fatigue," and "long and irregular hours." Under the heading of insanitary conditions, Taylor identified two major sub-categories, "hygienic surroundings which are not inherent in the trade itself and those conditions which are to a certain extent necessitated by the character of the trade." Among the latter, he wrote that "the dust producing trades each lead as producers of tuberculosis and especially those in which the dust-particles are very irritating." Taylor identified stonecutters, grinders, cigar workers, lead and copper miners, and others as at risk. Furthermore, he noted that these workers were usually "strong well-developed men," but they suffered from enormous death rates from tuberculosis [24]. In the hands of reformers in and out of government, statistics and data collection became powerful tools for education, analysis, and agitation [25].

This social analysis had an influence on the world view of an elite group of statisticians and social planners. Frederick Hoffman, the statistician for The Prudential Life Insurance Company, and Louis Dublin, his counterpart at Metropolitan

Life, were especially receptive because it helped to explain morbidity and mortality data on the industrial work force that these insurance giants were accumulating. In the late 1800s, these two companies were the largest and most important commercial insurers of working-class Americans. They pioneered in the provision of "industrial insurance," which provided minimal life and burial insurance for laborers. Unlike common life insurance, industrial insurance depended on an extensive network of agents who, on a weekly basis, would visit workers' homes to collect premiums of five and ten cents per family member. By 1910, industrial insurance was a three billion dollar business, with Metropolitan Life and The Prudential handling over 80 percent of all premiums. In that same year, more than 23 million Americans held industrial policies, with more than 19 million covered by these two companies [26].

Because these two insurance giants' success depended on the changing mortality picture among the various industries and population groups, their statisticians gathered enormous amounts of data documenting disease, disability, and death rates among every conceivable industrial population. They developed actuarial charts for blacks, whites, Indians, women, men, children; miners, steel workers, bakers, quarry workers, white-collar workers, and wage earners in scores of other industries. At the turn of the century, state and federal labor and health departments were just beginning to assume a major role in gathering statistics on the health of the work force. Thus, statisticians, such as Hoffman at The Prudential and Lee Frankl and Louis Dublin at Metropolitan, undertook investigations of their own which became the basis for many state and federal reports [27].

Unlike the new public health epidemiologists who focused their attention on the diseased as a source of infection, Hoffman sought to understand disease as a reflection of community structure and organization. For example, Frederick Hoffman found it necessary to take extended tours of the communities in which The Prudential had extensive interests in order to document the industrial, home, and community factors that affected mortality and morbidity rates. In towns all along the way he would conduct what we would today recognize as detailed epidemiological and ecological studies of the relationship between health and community development. He would arrive in a community in the afternoon and begin developing a detailed profile of that town's health experience. Sometimes he would begin by heading directly to the cemetery, where he would spend several hours noting the dates of birth and death from the tombstones. In his hotel in the evening, he would develop a detailed actuarial chart on the age-specific mortality of different populations over time. He would spend the next day visiting the local mine, mill, or smelter. He would travel into the shaft of a mine, chronicling the safety and health risks associated with every phase of production. He talked to company officials, gathering data about the number of accidents, the incidence of sickness including pneumonia, tuberculosis, and lead poisoning. He would follow up on this data gathering by visiting local physicians, coroners, funeral homes, and the local library to corroborate the picture that he heretofore had developed. If The Prudential already insured workers in that community, he would compare this information with data that he had gathered through his own claims department. If the company had not yet moved into the town, he would make a recommendation to the President whether to move into the community and, if so, which groups of workers to insure [28].

Hoffman helped to unmask silicosis as a distinct condition in the United States. His reading of the European literature had convinced him that the interests of the

insurance industry were diverging from those of the medical and public health professionals. In his study, *The Mortality from Consumption in Dusty Trades* (1908), Hoffman pointed out that "human health was much influenced by the character of the air breathed and that its purity [was] a matter of very considerable sanitary and economic importance" [29]. He directly contradicted the prevalent assumption among clinicians who saw tuberculosis and other infectious diseases as the primary threat to the average workman. "The sanitary dangers of air contaminated by disease-breeding germs are probably not so serious as generally assumed," he began. Rather, "the destructive effects of the dust-laden atmosphere of factories and workshops are a decidedly serious menace to health and life." He maintained that there was actually a "paucity of bacteria in very dusty air." But that "dust in any form, when inhaled continuously and in considerable quantities, is prejudicial to health because of its inherent mechanical properties, destructive to the delicate membrane of the respiratory passages and the lungs." And "I doubt if these bacilli actually develop phthisis unless there be some antecedent change in the vitality of the affected tissue. . . . In other words, I look upon a phthisical lung as one prepared for the germination and multiplication of bacilli [by dust], and not a primary product of those microscopic organisms . . ." [30].

Hoffman's 1908 study was significant in that it built on the evidence presented in the British material and the progressive social analysis as developed by the reformers. What was new was his use of statistical materials to challenge the clinical viewpoint of the medical and public health professions. In doing so, he was providing a new tool that gave legitimacy to the popular view that dust was dangerous to health.

The statisticians' methods were used to link industrial dust and tuberculosis. Hoffman noted that "in the group of occupations exposing chiefly to the inhalation of metallic dust" the mortality from consumption was over a third greater than overall mortality among industrial workers. His detailed, age-specific analysis of the mortality data led him to conclude that different types of dust created different patterns of mortality from consumption. "Dust from any hard stone (such as flint, granite, sandstone, etc.) is undoubtedly very injurious to the lungs, producing a marked predisposition to phthisis." He noted, however, that other dusts produced in coal mines and cement factories did not have the same effect on the work force.

While Hoffman in his 1908 report was documenting the complexity of the problem of the relationship between phthisis and dust, his analysis reached only a portion of the medical and public health community. Phthisis was still synonymous with tuberculosis as far as the bulk of the medical profession in the United States was concerned. While European and British investigators had largely accepted this changed conception, clinicians and pathologists in the United States largely ignored the new data. Concerned primarily with the pervasive effect of tuberculosis among individual patients and working with a heterogeneous clientele from diverse occupations and backgrounds, doctors saw little significance in this new model of lung disease. Within such important medical journals as the *Journal of the American Medical Association*, *The Boston Medical and Surgical Journal*, and *The Pennsylvania Medical Journal* there was barely a mention of the new paradigm arising from Hoffman's and the British literature.

Even the public health profession, which had a greater familiarity with population-based statistics, was slow to understand the significance of the data emerging from the statisticians. In the early years of the century, the profession was isolated from

the social turmoil created by the new industrial conditions. Unlike the insurance industry or the social reformers whose interests and activities forced them to confront the effect of industrialization on the life of the work force, the public health profession was still primarily concerned with the problems of infectious disease among populations in the urban centers and ports. There was little attention to the problems of the industrial worker at the work site and no attention to dust diseases which were non-infectious. Industrial hygiene was not even a recognized field. Campaigns against “phossy jaw” and for safety in factories and mines were carried out by labor unions, muckrakers, social welfare reformers, and settlement workers rather than by medical and public health professionals. Furthermore, factory inspections were the province of labor departments. In an article published in the popular weekly *The Outlook*, one author described the “work that kills,” noting particularly that census reports should specify the occupations that expose “the worker to the constant inhalation of irritating dust” [31]. In Illinois, the State Factory Inspector pointed to the deleterious effects of dust on workers in metal polishing, buffing, and grinding, and, in New York State, the Factory Investigating Commission that was organized following the Triangle Shirtwaist fire held hearings on the dust conditions in a number of upstate industrial concerns [32].

While individuals in the public health movement such as C.-E.A. Winslow and Alice Hamilton participated in these larger movements, it was not viewed as an intrinsic part of the mandate of public health [33]. Only in the second decade of the twentieth century, well after Hoffman’s first study had been published, the public health profession took official notice of industrial hygiene and even then rarely incorporated factory conditions into its campaigns to control tuberculosis and other infectious diseases among the industrial work force [34]. As late as 1922, Hoffman complained that there was too much emphasis on the sanatoria treatment of tuberculosis and too little on prevention. He noted that of the numerous recommendations of the committee on tuberculosis policy of the Conference of State and Provincial Boards of Health in 1919, “there is not a single reference to the dust problem. . . . Until the industrial aspects of the disease, and particularly the dust question, are more clearly realized, there is little hope of a reduction of tuberculosis frequency among industrial workers” [35]. Hoffman, the statistician, challenged the prevalent assumptions of the new public health worker who maintained that “to control tuberculosis, it was not necessary to improve the living conditions of the one hundred million people in the United States, only to prevent the 200,000 active tuberculosis cases from infecting others” [36].

In 1915, the public health profession slowly began to accept interpretations promoted by the statisticians and reformers. It was in that year that the United States Public Health Service was first granted authority to investigate “occupational diseases and the relation of occupations to disease” and organized a Section of Industrial Hygiene and Sanitation. Shortly thereafter, the American Public Health Association formed its own section of Industrial Hygiene [37]. By the end of the Progressive era, officers in the United States Public Health Service were increasingly struck by the importance of the workplace, in addition to the home, as a major predisposing factor affecting workers’ health. In a major study of health insurance conducted by two senior United States Public Health Service officials, B.S. Warren and Edgar Sydenstricker, the Service concluded that “there is no longer any doubt that modern industry is responsible for a considerable proportion of workingmen’s

physical ills" [38]. A few of the state departments of health took an active and sustained interest in occupational diseases, most notably Ohio, under the leadership of Emery R. Hayhurst. In a massive study of industrial hygiene in Ohio, published in 1915, Hayhurst pointed to the problem of dust in producing pneumoconioses, independent of tuberculosis. Citing the dangers of iron dust, coal dust, cotton dust, and silica dust, Hayhurst drew on Hoffman and Oliver to conclude that these dusts produced a fibrosis which result "in the end, in a condition called *phthisis*, which is usually complicated by the presence of the *bacillus tuberculosis*" [39].

Throughout the early decades of the century, the desire to differentiate tuberculosis from fibroid phthisis was frustrated by the problems associated with new medical technologies, for they often provided compromised information to interested investigators. By the early 1900s, the invention of the X-ray combined with the development of the tuberculin test and bacterial analysis of sputum could be used as evidence to distinguish between infectious and fibroid forms of phthisis. Over the course of the first two decades, the tuberculin test was gradually introduced as a tool for distinguishing those exposed to the bacillus and those not. Even with the improvements in technology, however, differential diagnosis of these lung conditions was fraught with uncertainty. X-ray readings were an inexact science at best. As late as 1941, textbooks noted the difficulty in distinguishing silicosis from tuberculosis by use of X-rays, even in conjunction with other diagnostic tools. "If there have been no previous films of the patient's chest," remarked Holmes and Ruggles in their standard text, *Roentgen Interpretation*, "it may be very difficult, after a frank tuberculosis with cavitation has developed in such an individual, to determine how much of the picture is fibrous tuberculosis and how much is a preexisting silicosis" [40]. Others noted the "difficulties of diagnosing tuberculosis in the presence of silicosis" and that "the incidence of tuberculosis appears to vary considerably depending on methods used by different investigators" [41]. Furthermore, the extraordinary exposure of the general population to tuberculosis made the tuberculin test little more than a confirmation of an individual's presence in a society plagued by tuberculosis [42].

The acceptance of a distinction between silicosis and tuberculosis was established in the United States in spite of the weaknesses of the new technologies. The European and South African studies, together with the statistical materials about mortality of metal miners in the United States, aroused so much concern that in 1911 the United States Public Health Service and the Bureau of Mines initiated an investigation of the lung diseases of metal miners. This effort resulted in the identification of silicosis as a major health hazard for metal miners and other industrial workers.

In 1914, two federal agencies, the United States Public Health Service and the Bureau of Mines, initiated the first detailed community study of the disease that would prove to be a landmark in the discovery of chronic industrial disease. Conducted by A.J. Lanza, who would become a major figure in industrial hygiene in the years to come, the study focused on the Tri-State lead and zinc mining region of Missouri, Kansas, and Oklahoma. Although public health workers had accepted that heavy metal poisoning could produce chronic diseases, the significance of Lanza's study was his documentation that symptoms from toxic exposures could and did occur years and sometimes decades afterward. This extremely long period between exposure and disease added a whole new dimension to the understanding of chronic

disease in general and industrial lung disease in particular. Coming during the heady period when research scientists had accepted the primacy of bacteriological agents as the cause of disease, this new perspective brought into question many of the assumptions that then governed medical science. The accepted methodology relied on laboratory procedures to discover the germ or specific agent that created disease symptoms. But Lanza relied on a constellation of indirect indicators that substituted for the seeming precision of the laboratory. To diagnose silicosis or other occupational lung diseases, he depended upon the testimony of the worker that he or she had been employed in a dusty trade and used X-rays and evidence of shortness of breath. Unless a patient died and an autopsy was performed, it was impossible to develop the direct evidence that the bacteriological revolution had trained physicians to depend upon for a diagnosis.

It is not surprising that Lanza began his study by documenting the extraordinarily high rates of tuberculosis among miners and their families [43]. In Jasper County, Missouri, the death rate from this disease was over 20 per 10,000 residents in 1912, substantially higher than anywhere else in the state. But, at the same time, he showed that there was also a high incidence of non-tubercular lung disease that he initially called "miners' consumption." He drew on Hoffman's work to point out: "It is possible for a miner to have his lungs injured by rock dust, producing a condition that is not tuberculosis." Its symptoms were thickened and inelastic lung tissue, which led to shortness of breath, constant cough, lessened working ability, and loss of weight. He noted the close relationship between miners' con and tuberculosis and remarked on the role that tuberculosis played in accelerating the death of workers with "the con" [44].

The study exposed the horrendous toll of non-tubercular lung diseases [45]. The report noted that, of the approximately 9,000 workers employed in the area, about 30 percent had some form of silicosis. Furthermore, it defined three stages to the disease, with the first being characterized by "slight or moderate dyspnea [shortness of breath] on exertion" and the third marked by total or very severe disability. It graphically described the suffering that many of the miners experienced as the disease progressed: "If we can imagine a man with his chest bound with transparent adhesive plaster, we can form a mental picture of how useless were the efforts at deep inhalation made by these patients" [46].

Lanza examined 720 miners. Of these, 120 were diagnosed as having first-stage silicosis. Their average age was only 31 years, and they had been employed in the mines only 3½ to 4½ years on average. The Service investigators found another 142 men suffering from stage 2 silicosis; this group had averaged 11.6 years on the job and were, on the average, 32.7 years old. The group in the third and most serious stage numbered 68, and their average age was 37.8 years; they had been working, on average, 15.9 years as miners [47]. The Report concluded that "five years' steady work with exposure to flint dust is fairly certain to find the miner in at least the first stage of silicosis" [48]. The study also included a house-to-house survey to obtain information on miners who had already died. It concluded that "9.6 years . . . may be taken as the average expectancy of life in a miner with silicosis, dating from the time he commenced hard-rock mining" [49]. The Report summarized the horrible conditions of work and life in an area that later would be called "a virtual hellhole" [50]. Not only were workers suffering from silicosis, but they and their families had extraordinarily high rates of tuberculosis due to the wretched working conditions. Of

the sample of 720 miners, the Service found that over 100 had silicosis and tuberculosis, and 39 had uncomplicated tuberculosis.

Statistics once again proved a valuable tool in unmasking the true nature of silicosis. Throughout most of the nineteenth century, the death rate from consumption fluctuated between 30 and 40 per 10,000 population. In Massachusetts, at the end of the Civil War, consumption accounted for 35 deaths for every 10,000 people in the state. Beginning in the mid-1880s, the death rate from consumption began to decline rapidly—by the beginning of the twentieth century, only 18.5 deaths from consumption for every 10,000 people [51]. In the country generally, the death rate also declined, from 19.5 per 10,000 in 1900 to 9.7 in 1921 [52]. In Barre, Vermont, however, the death rate from pulmonary tuberculosis was, as late as 1919, over 23.3 per 10,000 persons, compared with 9 per 10,000 for the rest of the state, and going up, despite the relatively healthful living conditions of the granite workers [53]. Between 1896 and 1918, granite cutters saw the rate of tuberculosis rise from 25.7 per 10,000 to 95.3 per 10,000 despite a decline among the general population, for the same period, from 20.7 to 9.6 per 10,000. In spite of nearly identical rates in 1896, the granite cutters' rate rose 400 percent, while the general population's declined more than 50 percent.

Hoffman's and Lanza's uncovering of the intricate relationship between tuberculosis and silicosis illustrates the interaction of social movements and professional analysis. It was the long history of changing work conditions and labor unrest that brought Hoffman to the area in the first place and alerted him to the influence of changing work processes on the health of the work force [54].

One important case is the granite industry. In the first two decades of the twentieth century, steam-driven equipment replaced hand drills and sledgehammers in granite quarries throughout the nation. These quarries produced the large blocks of granite that would be chipped, carved, and crafted into the ornamental stone used for building facades, monuments and gravestones, columns, mantelpieces, doorsteps, and hearthstones. From deep cavernous pits in the earth's surface, men would cut giant blocks of stone that would be hoisted, loaded, and transported to the carving sheds where the craftsmen and operatives would cut, shape, and engrave the stone. In these sheds, power tools were introduced in the late nineteenth century, leading to increased production, speed-ups, dust, and disease. In the first decade of the twentieth century, the *Granite Cutters Journal*, the publication of the granite workers' union, contained numerous articles about the "stone cutters' consumption," closely linking its increase to the recent introduction of power tools and the continuing problem of poor ventilation in the sheds. Unlike prevalent medical opinion in the early years of the century that emphasized the bacterial origins of consumption, for granite cutters, it was the dust in the sheds where the granite was cut that was at the root of the scourge. In July 1905, an article "About The Dust Question" stressed the importance of better ventilation in the sheds. Toward the end of the first decade, it was apparent to the work force that "granite cutters' consumption" was a serious threat to the health of all workers in the sheds. During the course of the next year, the workers of the area had decided that conditions in the sheds were reason for action. During the summer, when the sheds were open, the use of the pneumatic tools that had been introduced over the course of the past decade was tolerable. But during the winter months, when the windows were closed in the sheds in order to conserve heat, dust was everywhere. The workers in Northfield, a granite center

about ten miles from Barre, voted in November 1909 that they would not use the pneumatic tools until the warmer weather, May 1, 1910, when the sheds would be opened up and ventilated. In response, the owners fired and locked out the workers, leading to a much wider job action in the granite sheds throughout the Barre area [55]. The specific demand of the workers was that use of pneumatic tools be eliminated during the winter months and that efforts be made to keep the shed free of dust at all times [56]. An agreement reached in February provided for an immediate pay increase and for the pneumatic tools not to be used until April 1. Employers had until June 1 to install dust removal equipment or the tool was to be permanently retired. Just before the June first deadline, the Barre granite cutters wrote to the national union that "it will be good-bye to the notorious trouble-making disease-breeding, hand surfacer tomorrow, unless properly equipped with suction fan or other device to remove the dust. . . . The hand surfacer is only a man killer at best, and the scrap heap where many of them will be consigned to is a fitting end for all such inventions" [57].

The strike over pneumatic tools was part of a much larger struggle over control of the work process, not only in the granite trade but also in a host of other industries during the late nineteenth and early twentieth centuries. During the Progressive era, popular perception of the deleterious effect of changing production processes in a host of industries reinforced epidemiological studies. In a discussion of the axe industry, one commentator described the decreasing time it took different nationalities to recognize its health hazards. "When I came here 40 years ago [1880] I found the victims among the Yankees who had ground some 20 years before. Those could grind 18 or 20 years before having to give it up. The French-Canadians were then grinding. They could work 12 to 16 years. They became frightened off and the Swedes took up the work. They would get the disease in 8 or 10 years. Now the Finns and Polanders are at it, and they last only 3 to 5 years, and the disease is more common among them." In the foundry and metal-mining industries, this general conflict over routines, pace, and technological innovation that has been described so elegantly by David Montgomery and others was fought out around health and disease [58].

The significance of the granite cutters' objections to pneumatic tools as a source of disease and the resultant labor strife surrounding workplace control did not escape investigators. Frederick Hoffman helped organize a study for the United States Department of Labor Working Conditions Service on the prevalence of tuberculosis and silicosis, and his preliminary report began with an acknowledgment of the importance of labor in bringing the issue to his attention by quoting from a letter from Mr. Walter W. Drayer, General Secretary and Treasurer of the Journeymen Stone Cutters' Association of North America. In his letter, Drayer noted that, during the second decade of the twentieth century, there had been an "almost universal installation" of the air-hammer in the limestone and granite industries. He went on to detail the devastating effects of the use of this new technology on the health of the workers: "The use of the pneumatic hammer subjects our members to more danger in the contracting of tuberculosis than do the tools of our trade—the mallet and hammer—in as much as the vibration or stroke of this hammer is constant, thus emitting a steady stream of this fine dust into the face and nostrils of the operator, while with the tools of the trade there was, of course, an interval between the blows which gave the dust some opportunity of being carried away in the air" [59]. Hoffman agreed with their assessment about the effect of the introduction of high-speed drills

on the health of stonecutters. In 1919, while preparing to join in this health investigation of the quarry workers in Barre, Vermont, Alice Hamilton wrote that "There is an interesting dust problem out here [in Barre], so confused with labor difficulties that it is impossible to obtain any impartial information on it" [60]. Hamilton and Hoffman took issue with the public health community's perspective, which emphasized poor living conditions as a necessary precondition for tuberculosis, by noting that the granite cutters had among the best living conditions and physical appearance of all industrial workers. Hoffman remarked that they lived "under sanitary conditions above the average" and that their "housing conditions . . . are also above the average" of most workers, "so that the possibly unfavorable environmental factors are of decidedly secondary importance." Furthermore, the workers had "a superior physique, indicative of a higher degree of disease resistance." How then explain their devastating health experience, especially the excessive deaths due to tuberculosis? Given the favorable general living conditions of the work force, one should expect improved longevity and lowered tuberculosis rates. Hoffman believed that disease was proportionate to the length of time workers were exposed to silica on the job rather than to their exposure to germs at home.

By the mid-1920s, few doubted Hoffman's conclusion that silicosis in and of itself was the primary problem affecting the workers of Barre, Vermont. Numerous investigators from the Public Health Service, Vermont Department of Health, Vermont Industrial Hygiene Division, and the union began exhaustive studies documenting the prevalence of this disease [61]. The Public Health Service and others would continue studying the occurrence of silicosis among granite workers for decades to come [62], but effective reform of working conditions would not be initiated until the late 1930s, after a series of crises had affected not only the granite industry, but the nation's foundry workers, metal miners, potters, glassblowers, and metal grinders as well.

In the 1920s, a new field emerged that integrated several different traditions and perspectives. Industrial hygiene in the 1920s assumed a varied character that reflected the various traditions from which it arose during the Progressive era. Industrial hygienists counted among their number public health and urban reformers, the new medical and public health bench scientists and professionals, and, finally, physicians, engineers, and other personnel employed by industry. The reformers emphasized working conditions, wages, and hours in their fight for better health. The newer generation of industrial hygienists were primarily physicians whose training led them to see industrial disease in much narrower terms. This group emphasized personal hygiene, the laboratory, and identification of specific toxins or germs in their attempt to improve workers' health. The third group, drawn from the ranks of the company doctor, industrial engineers, and newly emerging industrial welfare departments, also tended to emphasize individual responsibility and susceptibility rather than corporate or societal factors in their analysis.

By the 1920s, silicosis was established as an important industrial diseases [63]. No longer merely an idiosyncratic industrial dust disease in a "cabinet of curiosities," it clearly affected important American industries. But silicosis was perceived as a problem affecting rural, relatively isolated populations in widely scattered communities in the non-industrial states. Joplin, Missouri, Coeur d'Alene, Idaho, Barre, Vermont, or even Quincy, Massachusetts, were not likely to gain national attention because their populations were being devastated by an obscure disease. One

indication of the lack of political concern about the disease was that none of the workers' compensation legislation passed between 1911 and 1925 included silicosis as a compensable condition. Silicosis had been created as a disease category but was not yet understood to be a national health problem. It would take a crisis in an industry critical to the national economy to make this a condition capable of capturing the attention of the vast majority of practitioners or the imagination of the American public. And that would have to await the social and economic crisis that would affect workers, management, public health and medical professionals alike during the Depression of the 1930s.

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